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Taniguchi

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(54) **LIQUID-SURFACE DETECTION DEVICE**

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G01F 23/62 (2006.01)

(52) **U.S. Cl.**

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(58) **Field of Classification Search**

CPC G01F 23/00; G01F 23/0007; G01F 23/30-76; F01M 11/12
See application file for complete search history.

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(57) **ABSTRACT**

A float floats on a liquid inside a container and is movable upward and downward according to a liquid surface level. A cover is located inside the container and houses the float inside the cover. A detector detects the position of the float. The cover includes a support part and a wall part. The support part allows upward and downward displacement of the float and restricts displacement of the float outward from the cover. The wall part is located around the support part. The wall part has an opening that allows communication between the inside of the cover and the outside of the cover. The area of the opening is larger than the surface area of the wall part except the opening.

4 Claims, 3 Drawing Sheets

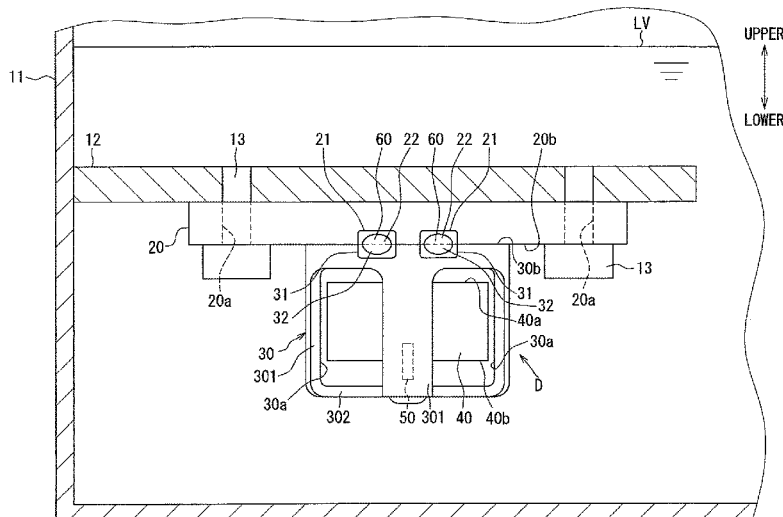


FIG. 2

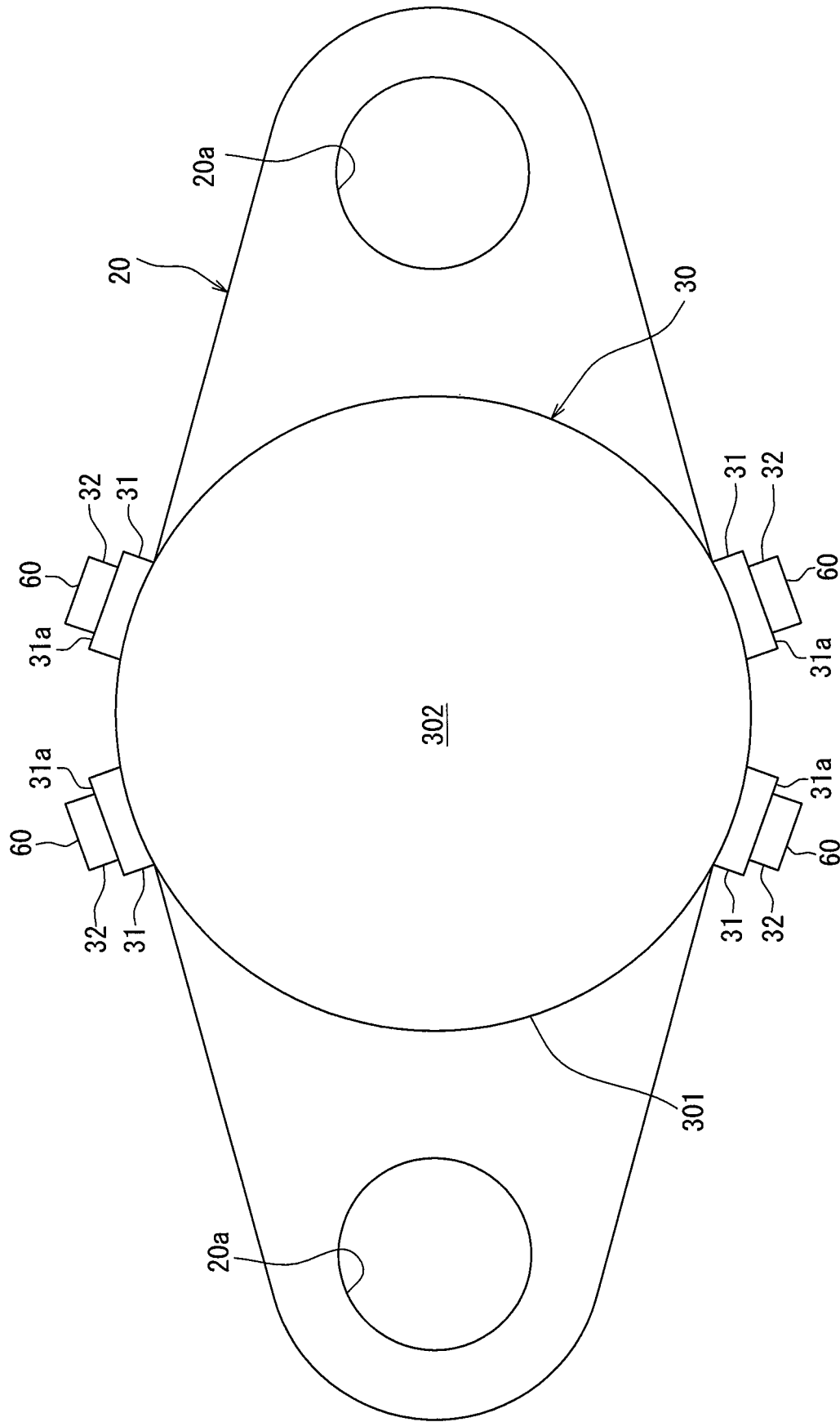


FIG. 3

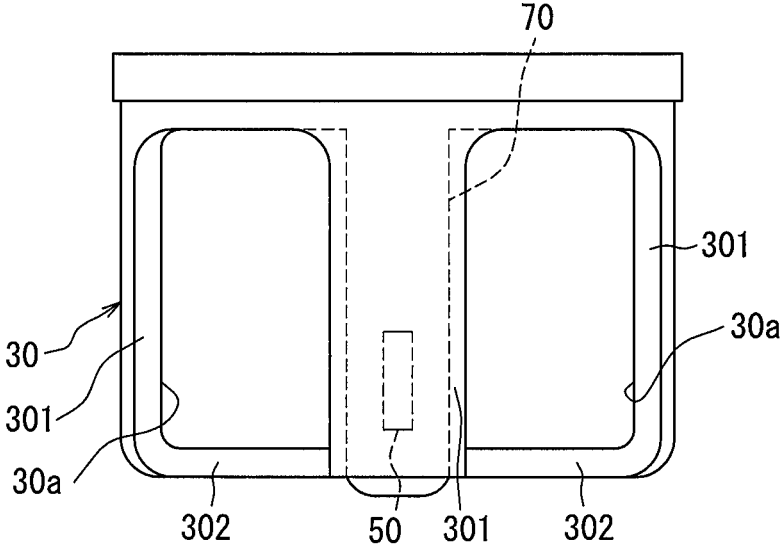
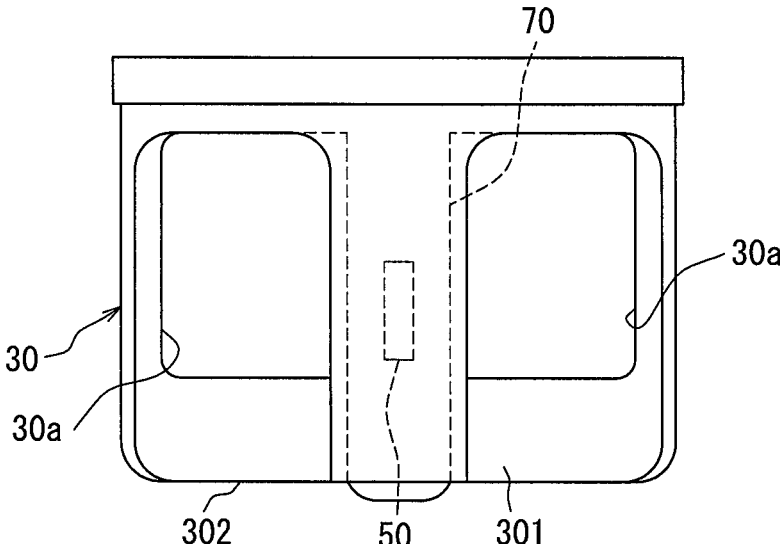


FIG. 4



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LIQUID-SURFACE DETECTION DEVICE**CROSS REFERENCE TO RELATED APPLICATIONS**

This application is a U.S. National Phase Application under 35 U.S.C. 371 of International Application No. PCT/JP2016/081201 filed on Oct. 21, 2016 and published in Japanese as WO 2017/134867 A1 on Aug. 10, 2017. This application is based on and claims the benefit of priority from Japanese Patent Application No. 2016-020865 filed on Feb. 5, 2016. The entire disclosures of all of the above applications are incorporated herein by reference.

TECHNICAL FIELD

The present disclosure relates to a liquid-surface detection device configured to detect the height of the surface of a liquid inside a container.

BACKGROUND ART

Patent Literature 1 describes a liquid level detector that detects the height of the surface of a liquid stored in a container. The liquid level detector of Patent Literature 1 includes a body attached inside the container. A float which floats on the liquid inside the container and a detection element which detects the position of the float are mounted on the body. The float and the detection element are enclosed with a cover having a bottomed tubular shape and accommodated inside a space which is formed by the body and the cover. In the liquid level detector of Patent Literature 1, the float inside the accommodating space moves upward and downward in response to changes in the liquid surface, and the detection element detects whether the liquid surface reaches a predetermined liquid surface height.

PRIOR ART LITERATURE

Patent Literature

PATENT LITERATURE 1: JP-2014-235158-A

In the above liquid level detector described in Patent Literature 1, a communication hole is formed on the cover. Oil enters the inside of the cover through the communication hole, and the detection element detects the position of the surface of the oil remaining inside the cover. Not only oil, but also air bubbles pass through the communication hole of the cover. Thus, the air bubbles may remain inside the cover and push the float down, which may result in erroneous detection by the detection element.

SUMMARY OF INVENTION

It is an object of the present disclosure to provide a liquid-surface detection device configured to restrict erroneous detection of a float caused by air bubbles.

According to one aspect of the present disclosure, a liquid-surface detection device is configured to detect a liquid surface level of liquid stored inside a container. The liquid-surface detection device comprises a float configured to float on liquid inside the container and movable upward and downward according to the liquid surface level. The liquid-surface detection device further comprises a cover configured to be located inside the container and houses the float inside the cover. The liquid-surface detection device further comprises a detector configured to detect a position

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of the float. The cover includes a support part configured to allow upward and downward displacement of the float and to restrict displacement of the float to an outside of the cover. The cover further includes a wall part located around the support part. The wall part has an opening configured to allow communication between an inside of the cover and the outside of the cover. An area of the opening is larger than a surface area of the wall part excluding the opening.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present disclosure will become more apparent from the following detailed description made with reference to the accompanying drawings. In the drawings:

The above and other objects, features, and advantages of the present disclosure will become more apparent from the following detailed description with reference to the accompanying drawings. In the drawings:

FIG. 1 is a sectional view illustrating, in a simplified manner, a state in which a liquid-surface detection device of a first embodiment is mounted on a vehicle;

FIG. 2 is a bottom view illustrating the liquid-surface detection device;

FIG. 3 is a front view illustrating a cover; and

FIG. 4 is a front view illustrating a cover of a second embodiment.

DESCRIPTION OF EMBODIMENTS

Hereinbelow, multiple embodiments for carrying out the present disclosure will be described with reference to the drawings. In each of the embodiments, a part corresponding to an item already described in the preceding embodiment may be denoted by the same reference sign as the preceding embodiment or the preceding reference sign with one letter added to avoid repetitive description. In each of the embodiments, when only a part of a configuration is described, the other part of the configuration is similar to that of the preceding embodiment. Further, in addition to a combination of configurations clearly stated in each of the embodiments, embodiments may be partially combined unless there is an obstacle in the combination.

First Embodiment

A first embodiment of the present disclosure will be described with reference to FIGS. 1 to 3. A liquid-surface detection device D illustrated in FIG. 1 is mounted on an internal combustion engine of a vehicle and detects a liquid surface level LV of a lubricating oil. The lubricating oil is used in the internal combustion engine mounted on the vehicle and stored in an oil pan 11 which is attached to the lower part of a cylinder block included in the internal combustion engine. The oil pan 11 is formed of metal in a bottomed cup shape and fixed to the cylinder block of the internal combustion engine in the vehicle. The oil pan 11 covers a bottom opening of the cylinder block to store the lubricating oil for lubricating a sliding part of the internal combustion engine. When the internal combustion engine revolves, air gets mixed as air bubbles into the lubricating oil which is stirred by, for example, suction by an oil pump through a strainer or scraping by an oil scraper of a connecting rod.

An arrow indicating the upper and lower direction of FIG. 1 indicates the upper and lower direction of the liquid-surface detection device D in a mounted state on the vehicle.

A cantilever **12** which is made of metal and projects in the horizontal direction is attached to the inner face of the oil pan **11**. The liquid-surface detection device **D** is fixed to the cantilever **12** with a bolt **13**.

The liquid-surface detection device **D** outputs a detection signal when the liquid surface level **LV** of the lubricating oil inside the oil pan **11** becomes a predetermined level or less. For example, when the liquid-surface detection device **D** outputs the detection signal, a display device which is installed inside a cabin of the vehicle performs alarm display notifying the shortage of the amount of stored lubricating oil.

Subsequently, a specific configuration of the liquid-surface detection device **D** will be described. As illustrated in FIG. **1**, the liquid-surface detection device **D** includes a body **20**, a cover **30**, a float **40**, and a detector **50**. The body **20**, the cover **30**, and the float **40** are formed of a resin material having excellent oil resistance. In particular, a thermoplastic resin is used as the body **20** and the cover **30**. The body **20** has a plate shape and includes a bolt hole **20a**. The body **20** is fixed to the cantilever **12** with the bolt **13** inserted through the bolt hole **20a**. The body **20** is located under the cantilever **12**. The cover **30** is located under the body **20**.

The cover **30** has a bottomed cylindrical shape and includes a wall part **301** having a cylindrical shape and a bottom part **302** which closes the lower end of the wall part **301**. Thus, the wall part **301** is located on the outer periphery of the bottom part and extends upward and downward. As illustrated in FIG. **3**, the cover **30** includes a support part **70** which extends upward from the bottom part **302**. The upper end of the wall part **301** is closed by the body **20**. The float **40** is housed in an internal space of the cover **30**. The internal space is surrounded by the cover **30** and the body **20**.

The support part **70** supports the float **40**. The support part **70** allows an upward and downward displacement of the float **40** and restricts a displacement of the float **40** to the outside of the cover **30**. The support part **70** has a columnar shape and supports the float **40** with the support part **70** inserted through the float **40**. The float **40** is located movably in the upper and lower direction within a predetermined range inside the cover **30**. Specifically, a lower limit position of the float **40** is a contact position with the bottom part **302** on the lower side, and an upper limit position of the float **40** is a contact position with the body **20** on the upper side. Thus, the bottom part **302** restricts the float **40** from dropping. The float **40** is a member having a smaller specific gravity than the lubricating oil and formed in an annular shape. The float **40** is coaxially located outside the support part **70** and guided along the support part **70**. The float **40** floats on the surface of the lubricating oil so as to move upward and downward according to the liquid surface level **LV**.

A large opening **30a** is formed on the wall part **301**. The lubricating oil flows into or flows out of the cover **30** through the opening **30a**. Thus, when the liquid surface level **LV** of the lubricating oil stored in the oil pan **11** is located at the position illustrated in FIG. **1**, that is, located above a housing chamber, the housing chamber is filled with the lubricating oil, and the float **40** is located at the upper limit position within the predetermined range. When the liquid surface level **LV** of the lubricating oil stored in the oil pan **11** decreases below the position of the bottom part **302**, and the position of the float **40** also decreases with the decrease in the liquid surface level **LV**. In the following description, the position of the float **40** when the liquid surface level **LV** of the lubricating oil decreases to the position of the bottom part **302** is referred to as the lower limit position.

The detector **50** detects whether the position of the float **40** in the upper and lower direction is the lower limit position or lower. The detector **50** is a contactless element and detects, for example, the intensity of a magnetic field generated by a magnet (not illustrated) which is attached to the float **40**. That is, the detector **50** is located in such a manner that the magnetic field intensity to be detected exceeds a threshold when the float **40** is located at the lower limit position or lower. The detector **50** may output an ON signal when the detected magnetic field intensity exceeds the threshold or may output an analog signal corresponding to the detected magnetic field intensity. In a case where an analog signal is output, a circuit component (not illustrated) may determine whether the magnetic field intensity exceeds the threshold and may output an ON signal when the magnetic field intensity is determined to exceed the threshold.

A change in the liquid surface level **LV** causes a change in the magnetic field generated by the magnet attached to the float **40**. Further, the detector **50** converts the magnetic field change to an electric signal and outputs the electric signal. Accordingly, the configuration enables to detect the amount of lubricating oil remaining inside the oil pan **11**.

As illustrated in FIGS. **1** and **2**, cover side bases **31** are formed on the wall part **301** of the cover **30**. Each of the cover side bases **31** has a shape projecting in the radial direction from the outer peripheral face of the wall part **301**. A cover side welding part **32** is formed on a projecting end face **31a** of each of the cover side bases **31**. The cover side welding part **32** has a shape projecting in the radial direction of the wall part **301**. The cover side welding part **32** partially projects from the center of the projecting end face **31a**. That is, the cover side base **31** and the cover side welding part **32** are formed in a shape having a step as illustrated in FIG. **2**. The cover side bases **31** are formed at multiple positions of the wall part **301**, respectively. The cover side welding part **32** is formed on each of the cover side bases **31**. The cover side welding parts **32** and the cover side bases **31** are resin-molded integrally with the wall part **301**.

Similarly, body side bases **21** are formed on the body **20**. Each of the body side bases **21** has a shape projecting from the outer peripheral face of the body **20**. A body side welding part **22** is formed on a projecting end face of each of the body side bases **21**. The body side welding part **22** has a shape further projecting in the same direction as the projecting direction of the body side base **21**. The body side welding part **22** partially projects from the center of the projecting end face. That is, the body side base **21** and the body side welding part **22** are formed in a shape having a step similar to the cover side welding part **32** and the cover side base **31** of the cover **30**. The body side bases **21** are formed at a plurality of positions on the outer peripheral face of the body **20**. The body side welding part **22** is formed on each of the body side bases **21**. The body side welding parts **22** and the body side bases **21** are resin-molded integrally with the body **20**.

The body **20** and the cover **30** are installed in such a manner that a lower face **20b** of the body **20** and an upper face **30b** of the cover **30** are in surface contact with each other. In such an installed state, each of the body side welding parts **22** and the corresponding one of the cover side welding parts **32** are also in surface contact with each other and welded to each other. That is, a molten and solidified part **60**, which is thermally molten to be integrated and then cooled to be solidified, is formed on the surfaces of the body side welding part **22** and the cover side welding part **32**. A imaginary line indicated in the molten and solidified part **60**

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in FIG. 1 is a boundary line that divides the body 20 and the cover 30 before welded. The body side welding parts 22 and the cover side welding parts 32 are joined together by welding in this manner, so that the cover 30 is fixed to the body 20.

Subsequently, the shape of the cover 30 will be described with reference to FIG. 3. FIG. 3 illustrates a state in which the cover side bases 31 and the cover side welding parts 32 are omitted to facilitate understanding. The cover 30 includes the support part 70, the wall part 301, and the bottom part 302 as described above. The wall part 301 is located around the support part 70. The wall part 301 has the opening 30a which allows communication between the inside of the cover 30 and the outside of the cover 30. As illustrated in FIG. 1, the area of the opening 30a is larger than the surface area of the wall part 301 excluding the opening 30a. The surface area of the wall part 301 is the surface area when the wall part 301 is viewed from the lateral side of FIG. 1.

The opening 30a extends in the upper and lower direction. The opening 30a includes four sections that are formed at intervals in the circumferential direction. In other words, the wall part 301 is located between adjacent sections of the opening 30a that are adjacent to each other in the circumferential direction. Thus, the wall part 301 is also divided into four sections and extends in a cross shape when viewed from the bottom part 302. In the circumferential direction, the dimension of the opening 30a is larger than the dimension of the wall part 301.

When the float 40 is located at the upper limit position due to floating of the float 40, an upper face 40a of the float 40 faces the opening 30a. In other words, when the float 40 is located at the upper limit position, the upper face 40a of the float 40 can be visually recognized through the opening 30a when viewed from the lateral side. Further, as illustrated in FIG. 1, when the float 40 is located at the lower limit position due to floating of the float 40, a lower face 40b of the float 40 faces the opening 30a. In other words, when the float 40 is located at the lower limit position, the lower face 40b of the float 40 can be visually recognized through the opening 30a when viewed from the lateral side. Thus, the float 40 can be constantly visually recognized through the opening 30a.

As described above, the liquid-surface detection device D of the present embodiment has the opening 30a which is formed on the wall part 301 of the cover 30. The opening 30a is larger than the surface area of the wall part 301. Since the large opening 30a is formed, an escape route of air bubbles is large, and the configuration enables to restrict air bubbles from remaining inside the cover. Thus, the configuration enables to restrict a change in the position of the float 40 caused by air bubbles and to restrict erroneous detection of the float 40 by the detector 50.

In other words, in order to restrict a malfunction in the float 40 caused by the stagnation of air bubbles, the opening 30a, which is a large window, is formed in the cover 30 to ensure an escape route of air bubbles. Further, depending on the shape of the cantilever 12, the lubricating oil may enter the inside of the cover 30 through the cantilever 12 and the body 20. When the lubricating oil enters the inside of the cover 30 from the upper side of the float 40 and the dropped lubricating oil collides against the float 40, the float 40 is pushed downward, and the detector 50 may cause erroneous detection. However, in the present embodiment, since the large opening 30a as described above resides, the lubricating oil that has collided against the float 40 easily escape through the opening 30a. Thus, the configuration enables to

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restrict the float 40 from being unusually pushed down by the dropped lubricating oil. Thus, the configuration does not require to closely join the cantilever 12 to the body 20, which improves the degree of freedom in designing the cantilever 12.

In the present embodiment, the liquid-surface detection device D detects the liquid surface level LV of an engine oil into which air bubbles are mixed by stirring in the internal combustion engine. The oil pan 11 is provided with the strainer, and the lubricating oil is stirred by the suction of the strainer. Thus, a through hole is formed on the cover 30 taking the flow of air bubbles into consideration in a conventional technique. However, in the present embodiment, since the opening 30a is large, it is not necessary to take the orientation and the position of the cover 30 into consideration regardless of the position of the strainer. Thus, the configuration enables to improve the degree of freedom in the installed position of the liquid-surface detection device D. As a result, a design change is not required depending on products, which enables standardization.

In the present embodiment, the cover 30 is made of a resin material. It is noted that, the large opening 30a formed on the cover 30 enables to reduce the material cost of the cover 30. Further, although the cover 30 is made of a resin material, the wall part 301 and the bottom part 302 of the cover 30 enables to ensure the strength for supporting the float 40.

In the present embodiment, when the float 40 is located at the upper limit position, the opening 30a is located at the position facing the upper face 40a of the float 40. Accordingly, the operating height of the float 40 can be measured by visual observation after the cover 30 and the body 20 are assembled to the cantilever 12, which results in an easy operation check by the position of the float 40.

Second Embodiment

Subsequently, a second embodiment of the present disclosure will be described with reference to FIG. 4. In the present embodiment, the size in the upper and lower direction of an opening 30a differs from that of the first embodiment. As illustrated in FIG. 4, the opening 30a does not face a lower face 40b of a float 40 at a lower limit position of the float 40. In other words, when the float 40 is located at the lower limit position, it is not possible to visually recognize the lower face 40b of the float 40 through the opening 30a.

Thus, the dimension in the upper and lower direction of the opening 30a is smaller than that of the opening 30a of the first embodiment as described above. A wall part 301 extends in the upper and lower direction from the entire circumference of a bottom part 302 and then branches into a cross shape by the opening 30a. Thus, the bottom part 302 and the wall part 301 are formed in a bowl shape at the lower side thereof. Thus, the bottom part 302 and the wall part 301 are capable of storing a lubricating oil.

A detector 50 is located in a part where the opening 30a is located in the circumferential direction. The detector 50 is configured to output a signal when the float 40 is located at the lower limit position.

Also with such a configuration, the opening 30a is sufficiently large. Thus, it is possible to let air bubbles escape to the outside of the cover 30 similarly to the first embodiment described above. Further, the bowl shape formed by the bottom part 302 and the wall part 301 can improve the strength of the cover 30.

Other Embodiments

The structures of the above embodiments are merely examples. The scope of the present disclosure is not limited to the scope described above.

In the above first embodiment, the opening **30a** includes the four divided sections. However, the number of divided sections of the opening **30a** is not limited to four and can be changed taking the strength of the cover **30** and an escape of the lubricating oil and air bubbles into consideration. Further, although the opening **30a** is divided in the circumferential direction, the opening **30a** may be divided into a plurality of sections in the upper and lower direction.

In the above first embodiment, the liquid-surface detection device **D** is a liquid-surface detection device for a vehicle. However, the present disclosure may be applied not only to a liquid-surface detection device for a vehicle, but also to liquid-surface detection devices that are located inside fuel tanks of various household apparatuses and various transportation apparatuses. Thus, the present disclosure may be applied to various liquid-surface detection devices that detect a liquid surface level **LV** of a liquid other than oil, the liquid being stored inside a container other than the oil pan **11**.

In the above first embodiment, the detector **50** which outputs an ON signal or an OFF signal by ON or OFF according to the liquid surface level **LV** is used. Alternatively, for example, a sensor whose signal voltage continuously varies according to the liquid surface level **LV** may be employed as another detector.

The liquid-surface detection device described above includes the float **40**, the cover **30**, and the detector **50**. The float **40** floats on a liquid inside the container so as to move upward and downward according to the liquid surface level **LV**. The cover **30** is located inside the container and houses the float inside thereof. The detector **50** detects the position of the float. The cover includes the support part **70** and the wall part **301**. The support part **70** allows an upward and downward displacement of the float and restricts a displacement of the cover to the outside. The wall part **301** is located around the support part. The wall part includes the opening **30a** that allows communication between the inside and the outside of the cover. The area of the opening is larger than the surface area of the wall part excluding the opening.

According to the present disclosure as described above, the opening larger than the surface area of the wall part is formed on the cover. Since the large opening is formed, an escape route of air bubbles is large, and it is possible to restrict air bubbles from remaining inside the cover. Thus, it is possible to restrict a change in the position of the float caused by air bubbles and restrict erroneous detection of the float by the detector.

Although the present disclosure has been described based on the embodiments, it is to be understood that the present disclosure is not limited to these embodiments and structures. The present disclosure also includes various modifications and modifications within the equivalent range thereof. In addition, various combinations or modes, and other combinations or modes including only one element, more, or less thereof are also included in the scope and idea range of the present disclosure.

What is claimed is:

1. A liquid-surface detection device configured to detect a liquid surface level of liquid stored inside a container, the liquid-surface detection device comprising:

a float configured to float on liquid inside the container and movable upward and downward according to the liquid surface level;

a cover configured to be located inside the container and houses the float inside the cover; and

a detector configured to detect a position of the float, wherein

the cover includes:

a support part configured to allow upward and downward displacement of the float and to restrict displacement of the float to an outside of the cover;

a wall part located around the support part; and

a bottom part, wherein

the wall part is located on an outer periphery of the bottom part and extends in an upward and downward direction, the wall part has an opening configured to allow communication between an inside of the cover and the outside of the cover, and

an area of the opening is larger than a surface area of the wall part excluding the opening, and

the bottom part and the wall part are configured to store liquid.

2. The liquid-surface detection device according to claim 1, wherein

when the float which floats is located at an upper limit position, an upper face of the float faces the opening.

3. The liquid-surface detection device according to claim 1, wherein

the cover is formed of a resin material.

4. The liquid-surface detection device according to claim 1, wherein

the container is an oil pan configured to store, as liquid, lubricating oil into which air bubbles are mixed due to stirring caused in an internal combustion engine.

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